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Thus the entire system of strict implication is included in the matrix algebra.

Aside from its comprehensive character, the matrix algebra for implications is useful as an instrument for investigating the interrelations of necessity, truth, possibility, falsity, and impossibility, and of such derivative relations as have figured in this paper. If the assumptions of this system are true, the consequences are important not only for logic, but also for epistemology and metaphysics.

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ARE REALISM AND RELATIVITY INCOMPATIBLE?

"The new realism," says Professor Lovejoy in a recent article in this Journal,[1] "from the first had in it a strain of relativism." "Yet a thinker of the true realistic temperament," he goes on to say, "craves a world of objects which have each *some* intrinsic and solid character, which do not endlessly deliquesce into mere relations to other things, themselves equally characterless and elusive. . . . But it appears to be the fact that practically these two incongruous motives were conjoined in the production of neo-realism in its American form."

I dare say that many of us are ready to subscribe to Professor Lovejoy's contentions as here expressed. I must differ with him, however, if he holds that the realist's craving for solid *things* and the principle of relativity are inherently "two incongruous motives."

It is true that realism is prone to ignore a dependence among objects and that relativity is disposed to the opposite error of discounting an independence among them. But relativity, properly conceived, must include a specific investigation into the nature of its terms just as realism finds and has found it incumbent to recognize the effect of relations. Hence, whether for a so-called realist or for a relativist, the conjunction of things and relations appears inevitable. It is easy to perceive why a conjunction between them may stand obscured and denied; for relativity, when brought to its formulation, is as commonly lacking in its account of *things* as realism is lacking in a precise definition of its special stumbling-block,—the nature and scope of relations. Many, I have no doubt, would be surprised to find to what extent John Locke has already struggled, with no mean success, to solve this very issue. In Book III. of his Essay (to paraphrase him as nearly as possible in his own language) he writes: objects exist in nature with a measure and boundary that appear prefixed; yet gold in one relation is solid and in another liquid, in one relation yellow and in another red, green, or what not. Moreover, men do not appear to agree in their conception of the simplest and most common of objects. How, then, do objects acquire such measure and boundary as they possess? Having presented this matter at large in two publications,[2] I shall merely revert to what I think is pertinent in those publications to the issue in question. In them I have attempted a complete formulation of relativity.

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[1] Vol. XI., page 421.

Since the crucial issue for relativity centers in a definition of *things,* we may state in advance that those formulations of relativity that terminate in a mere flux-doctrine or in the more widely current one that objects "endlessly deliquesce into mere relations," are doctrines that have hopelessly lost sight of their most difficult problem. A relativist's point of departure is the dynamic world; but realism, with its apotheosis of a static world, rises to overwhelm him at the very point where a relativist's chain of reasoning is invariably at its weakest—its impotence in the face of what is static. Independence is a characteristic of things, writes the realist. Let us see to what extent this realistic doctrine can compel a relativist to rescind the inadequate doctrine that objects "endlessly deliquesce into mere relations."

Underlying this particular formulation of relativity is the abstract conception that each object is involved in all and all in each. This sounds beautiful, but what basis has the conception? The conception emphatically denies on its very face that a partiality or an indifference exists in the effective relations of one object with another. But the principle of elimination as involved in our inductive methods (to cite but one instance) declares as emphatically at the outset that *disconnections* exist among things, so overwhelming and obtrusive in their presence, as to make the search for *connections* among some of them the most arduous object of a scientist's special endeavor. In fact, if no real disconnections exist then neither do connections exist, for the two ideas involve and presuppose each other at every point, and neither of them can claim a reality more ultimate than the other. It is thus that we come to recognize that the dependence of a given object in a given (circumscribed) situation may be large, yet the dependence of other objects upon it or upon each other in that particular situation may be zero. The unaffected objects are accordingly more properly designated as independent (in that situation). But an independence properly maintained for an object in certain situations may in other situations convert itself into a mere dependence, as our scientific postulate of a general dependence of an object would naturally dispose us to expect. This is the first significant distinction,—obvious, but abundantly overlooked, that I would insist upon; namely, that to talk of an object's general dependence, as a dependence of each object upon all, and of all objects upon each, and to talk of a particular object's dependence upon certain other specific objects in a given situation, or in a series of them held together in an idea (as in the case of gold), are very different things.[3] To exhibit this matter of connections and disconnections between its objects constitutes in large measure the central business of chemistry.

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[2] "Locke a Constructive Relativist," The Scientific Press, Brooklyn, 1912. "A New Conception of Relativity and Locke," University of Cincinnati Studies, 1914.

Objects, as we thus perceive, are not without independence. Independence is further assured and made obvious when we recognize how, in this dynamic world of connections and disconnections, objects are seen to be as effective in reinforcing each other and in preserving each other intact as they are in building each other up or in destroying each other; and, in still other cases, not only disdain to enter into certain effective relations, but even block effective relations which might otherwise have come into existence. It is to chemistry with its combining laws of substances that we again may turn for the most precise formulation of each statement here made.

These empirical observations in support of an independence acquire additional confirmation when considering abstract relativity in the light of the principle of conservation. Here we learn that objects or terms may displace and modify each other, but that the extinction of one term has its equivalence established in the creation of others. That is, abstract relativity, in contradiction to the principle of conservation, would reduce a certain term to zero by a total abstraction of it from the rest of the universe; but it fails to note that this abstraction of one of its terms argues some change or other of the remaining terms; and, if we adhere to the principle of conservation in its abstract form (a thing I would myself avoid), such changes may be maintained as affecting all of the remaining terms. These facts then, taken together, even in this summary statement of them, point to the conclusion that relativity (in its identity with the scientific postulate of general dependence) does *not* imply a total extinction of independence "into mere relations to other things, themselves equally characterless and elusive." Rather does the contrary hold true; without dependence there is no independence. How long, for example, would an object like "gold" preserve or realize its full independence (integrity) when the idea of gold, as generally recognized, and, in particular, as defined by a chemist, involves a host of qualities and properties which demand time and the most varied situations for their realization? Furthermore, without insinuating an arbitrary or biased standard of some kind or other, the qualities and properties it reveals in one situation are as truly to be considered of its nature as those it reveals in other situations. If a selection is made among them, the selection would intimate the existence of some new principle of control. But whatever the principle of organization that a specific object may involve, the fact remains, as in general true, that no single situation of actual existence can reveal or exhaust an object's total actuality, that is, all its possible phases or qualities.[4] It is in its very nature a mutiplicity viewed spatially or temporally. Hence when synthesized into a whole, our object assumes the character of a construct. But to preserve the independence (integrity) of such objects demands dependence. In so far, then, as we remain strictly empirical, and further, strictly adhere to our scientific postulate of general dependence, the following form of relativity seems the more permissible one: objects reveal themselves differently in different situations, and in different situations are capable of revealing qualities absolutely incompatible with each other.

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[3] Once recognize this distinction in its full effect, and we will be found to have an empirical foundation for real change and novelty in the world; for the organization of our world, whether of science or of every-day life, whether of man's or of nature's production, involves such an *interchange* of effective elements, that many of them never yet have been and perhaps never will be brought together. Many of them, of course, have been; but herein lies the sphere and foundation of real novelty or creation in our world, especially if we do not in this connection forget our chemistry and Hume's special teaching that the incommensurable issues from every new combination of objects or elements

But a mere proof of an *independence* is not a definition of *things;* for whatever other notion may be implied in our conception of a thing, a specific inclusion and exclusion of parts is inevitable to its specific and distinct recognition. Terms of some kind we must adopt, and in this conclusion we are justified by the relative independence of terms amid dependence and change; and it is to those aspects of reality where a term's substantiation may be gleaned, that realism is especially disposed to turn in defense of its demand for solid things. But *what* terms we must adopt, depends upon the nature of the problem in hand, and it is in this "what" aspect of terms that realism so commonly proves disappointing.

Turning attention, now, to this phase of the problem, the point of contact between relativity and realism opens up anew. Do objects exist in nature with a prefixed measure and boundary? If they do, what is the prefixed measure and boundary of every object? If they do not, what controls us in affixing such measure and boundary to objects as they acquire, however variable or identical the measure and boundaries are that are assigned to the objects about us? Thus we might ask: why does the average man and the physical chemist regard water, vapor, and ice as *three* things instead of following the lead of the general chemist in regarding them all as mere aspects of *one* and the same thing under varied conditions; namely, as aspects of H_2O, or all alike, including hydrogen and oxygen, as mere functions of weight? Relativity drives this problem home; realism, however, can not with impunity ignore it; for a mere reiteration that objects exist in nature with prefixed measure and boundary is no rational proof that such is the case, however much ultimately an agreement may manifest itself between the rational proof and the inarticulate protestations of common sense or good sense. I affirm, therefore, that realism and relativity in their common search for *things* (as previously in their common search for independence) focus in a common problem, the problem of the one-and-the-many.

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[4] The appreciation of this fact negates the idea of an Absolute of a completed reality. Time and varied situations are demanded in the realization of any complex reality, and the more complex the reality, the more largely does this demand apply.

To postulate an inherent essence (substance) in explanation of this problem will not help us, for in that case we postulate we know not what, as tradition from Locke through Kant has so fully taught. And where an object changes, and all objects do and can be made to change to an indefinite degree, the question arises to which group of its changing qualities shall I hold as representing *the* group of a particular object. Now chemistry has its own solution of the problem in its elementary substances just as modern physics has its present solution of it in electrons. As for philosophy (to quote from a recent book), "I do not say that it is impossible to solve the problem of the one-and-the-many, . . . but up to the present time no solution has been given."[5] Modern realism with its elusive and protean conception of an object would surely not offer its solution as a solution of the problem in hand. I wonder how long a chemist or a physicist would pause to receive the instruction thus offered.

Suppose, then, we accept the verdict of chemistry as provisionally valid. Our terms in that case are the elementary substances. The chemist regards them as irreducible and he regards them as constructs,—as specific groups of itemized properties demanding time and the most varied situations for their complete realization. But to speak of them as (1) irreducible and as (2) constructs involves a possible confusion. In this dual claim the one-and-the-many problem is as obviously evoked as in any other quarter. The difficulty is further accentuated when we read chemistry in the light of the electron as ultimate, whereby, as affirmed by many of the leading physicists of to-day, the electron and not the elementary substance becomes the desired term. And thus the issue of the one-and-the-many problem continues and, for all we know, always will continue. But the ideal simplicity of the "term" (and this is important), the special aim of both of these sciences, is not of necessity the only ideal. Often we aim to know the effect of a complex term upon other complex terms. For example, when I make lemonade I do not combine elements that are simple from the standpoint of chemistry, but I combine the complex thing "water" with the complex things "sugar" and "lemon juice." Or when I seek the effect of a violin concerto upon an audience, I do not resolve the complex things—violin box, strings, bow, the air, the player, etc.—into parts that are elementary from the standpoint of chemistry, physics, psychology, or what not, but I deal directly with the interdependence or relations of parts exceedingly complex. Hence all we seem entitled to affirm thus far is, that the scientific postulate, in so far as it signifies so-called *conditions* and so-called *results,* presupposes the existence of terms at every step of its operation. Terms thus come and go; but with terms in some form or other we begin and with terms in some form or other we end. Hence the realist in his assertions that complex things are or may be ultimate, has, from the standpoint of relativity, here hit upon a bigger truth than he in his reasoning may have actually known; for its background is a clearly accepted pluralism and a clearly accepted relativity. The truth, however, of the ultimate character of complex things (under conditions) is impregnable. In addition the thing a relativist in the rôle of a pluralist would emphasize is, that no set of conditions with its results has in its conditions or in its results a *monoply* upon reality, whether in one case we adopt the electrons of physics as the foundation or limits of the objects involved, or the elementary substances of chemistry, or a sensory *quale.* Under conditions, then, as Locke himself wrote, "an army, a swarm, a city, a fleet are things as perfectly one as a ship or an atom."

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[5] Russell, "First Course in Philosophy," 1913, page 90.

Consistently hold to the fact, then, (1) that unity, under conditions, may be validly assigned to any object, from an electron to the universe in its totality, and (2) to the principle that given conditions produce a given result—then, whatever the conditions, the result *is* reality. Break up that result into parts, if you choose, or synthesize the given result with other results and, together, organize them into a larger result; in either case we have *reality,* of which common practise offers certification. For if it be once admitted that objects exist in nature with no prefixed, natural, or inevitable unity or boundary of their own, then one boundary of them is no more true in the abstract than another, whether we proceed by the way of analysis to a pale and vapid *quale*, or by way of a synthesis advance to the Absolute of our objective idealists. Hence neither a *Ding an sich* nor a phenomenalism really has any meaning from a relativistic standpoint. A thing *is* what it reveals itself to be in any given situation, or, by a process of construction, *is* what it was found to be in a series of situations; and it logically remains entirely beside the issue whether a human organism, with its source for varied determination, constitutes a part of a situation or whether other objects do. For no set of conditions with its specific result, in the abstract, I repeat, has a prerogative or monopoly upon so-called reality. Constructs enter our world at every point, whether mechanical, industrial, artistic, scientific, or what not, and any one of them in its simplicity or in its complexity may become our real and actual point of departure in thinking as in action.

The length at which some writers, as Bergson for example, would decompose our ultimate units of knowledge because they are capable of a varied formulation or, in other cases, because they are capable of an indefinite analysis and decomposition, is not without error. Limits in these matters exist that Bergson and his confrères in anti-intellectualism are loath to admit or recognize. Thus we may add in the way of a refutation of these abstract claims that the *in*decomposable character of elements in chemistry is a far more rigid trait than their decomposable character, although some of the elements once thought of as indecomposable may slowly give way to a resolution coincident with the slow refinement of a complex technique elaborated in connection with them. Or again, in the case of our sense organism, is rigidity in and susceptibility toward the number, kind, and range of our sensations the conspicuous thing, or is it the opposite that is true? The answer is evident. Moreover, as stated, terms of an ideal simplicity—elementary substances, the electron, the *quale* of an immediate experience,—are not the only limits in the organization of our experiences. In the case of our violin concerto, limits present themselves that on their face are conspicuously complex. In fact, what would become of most of our sciences, in particular ethics, sociology, mechanics, if this were not the case? Limits exist, therefore, whether we move up or down for our unit; limits which, under conditions, make now one unit the basis of a synthesis and then some other.

When a thinker, therefore, in harmony with the scientific postulate of general dependence knocks at such limits, but refuses in his actual thinking to be controlled by them, he parts company with what is empirical, to launch forth at will in a sphere of delightful (!) abstraction. Secondly, if he recognizes but *one* such limit, as Professor Lovejoy, for example, gives expression to in his sensory *quale* as the experienced datum, he is an absolutist who sees but one possible aspect of reality and mistakes it, however partial or fruitless, as adequate in its resolution of the whole universe with all its inherent variety and complexities. But whether the thing is determined by one *quale* or by a multitude of them, or whether the *quale* is determined by the thing, he does not say. In either case there is presupposed a determination of the *quale* or of the thing that is openly at issue. Thirdly, if as the realist does, a thinker (1) mistakes a mere assumption of an independence for its proof, or (2) mistakes an undefined independence for a defined *thing,* or (3) conceives of an independence apart from dependence, we might in each case be thought to have a doctrine of reality, but they would be doctrines of such value as I leave with my readers to judge.

I have sought to prove that relativity, when identified with the scientific principle of general dependence in its conjunction with so-called uniformity of nature, recognizes a variety of limits, which, as long as they remain practical, are actual; and that such limits are as apt to present themselves validly in the form of an obviously complex synthesis as in the direction of a minute analysis. Physics, chemistry, and the theory of the sensory *quale,* in contrast with realism, to my mind, more clearly define the nature of the limits they involve, but they differ from realism in a less general declaration for independence and pluralism. Finally, that a relativity that is empirical and pretends to adequacy must incorporate such independence and pluralism in its formulation just as obviously as a realism must recognize the postulate of general dependence (relativity) if it would be scientific. And further, that realists no less than relativists, before they can talk of *things* in any proper sense of the term, must both alike turn to the one-and-the-many problem as a common heritage of a metaphysical difficulty, and that it is in connection with this problem that I see hope for a fuller and clearer recognition and definition of the varied limits involved in the varied organization of our very complex and evolved experience.

Not in the conjunction of realism and relativity, therefore, but in their supposed incompatibility, do I see philosophical confusion.

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